

References

Description

- Allan, E. J. (1991). Induction and cultivation of a stable L-form of *Bacillus subtilis*. *The Journal of Applied Bacteriology*, **70**(4), 339–343.
- Allan, E. J., Hoischen, C., & Gumpert, J. (2009). Bacterial L-forms. *Advances in applied microbiology* (1st ed., Vol. 68). Elsevier Inc. [http://doi.org/10.1016/S0065-2164\(09\)01201-5](http://doi.org/10.1016/S0065-2164(09)01201-5)
- Amano, K., Hayashi, H., Araki, Y., & Ito, E. (1977). The action of lysozyme on peptidoglycan with N-unsubstituted glucosamine residues. Isolation of glycan fragments and their susceptibility to lysozyme. *European Journal of Biochemistry / FEBS*, **76**(1), 299–307.
- Angala, S. K., Belardinelli, J. M., Huc-Claustre, E., Wheat, W. H., & Jackson, M. (2014). The cell envelope glycoconjugates of *Mycobacterium tuberculosis*. *Critical Reviews in Biochemistry and Molecular Biology*, **9238**, 1–39. <http://doi.org/10.3109/10409238.2014.925420>
- Atrih, A., Bacher, G., Allmaier, G., Williamson, M. P., & Foster, S. J. (1999). Analysis of peptidoglycan structure from vegetative cells of *Bacillus subtilis* 168 and role of PBP 5 in peptidoglycan maturation. *Journal of Bacteriology*, **181**(13), 3956–3966.
- Atrih, A., Zöllner, P., Allmaier, G., & Foster, S. J. (1996). Structural analysis of *Bacillus subtilis* 168 endospore peptidoglycan and its role during differentiation. *Journal of Bacteriology*, **178**(21), 6173–83. Retrieved from <http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=178487&tool=pmcentrez&rendertype=abs>
- Bera, A., Biswas, R., Herbert, S., & Götz, F. (2006). The presence of peptidoglycan O-acetyltransferase in various staphylococcal species correlates with lysozyme resistance and pathogenicity. *Infection and Immunity*, **74**(8), 4598–4604. <http://doi.org/10.1128/IAI.00301-06>
- Bernard, E., Rolain, T., Courtin, P., Guillot, A., Langella, P., Hols, P., & Chapot-Chartier, M. P. (2011). Characterization of O-acetylation of N-acetylglucosamine : A novel structural variation of bacterial peptidoglycan. *Journal of Biological Chemistry*, **286**(27), 23950–23958. <http://doi.org/10.1074/jbc.M111.241414>
- Boneca, I. G., Huang, Z. H., Gage, D. a., & Tomasz, A. (2000). Characterization of *Staphylococcus aureus* cell wall glycan strands, evidence for a new ?-N-acetylglucosaminidase activity. *Journal of Biological Chemistry*, **275**(14), 9910–9918. <http://doi.org/10.1074/jbc.275.14.9910>
- Bougault, C., Hediger, S., & Simorre, J. (2012). Solid-state NMR of the Bacterial Cell Wall. In H. S. Press (Ed.), *Bacterial Glycomics : Current research, technology and applications*.
- Bradshaw, W. J., Davies, A. H., Chambers, C. J., Roberts, A. K., Shone, C. C., & Acharya, K. R. (2015). Molecular features of the sortase enzyme family. *FEBS Journal*, **282**(11), 2097–2114. <http://doi.org/10.1111/febs.13288>
- Braun, V., & Rehn, K. (1969). Chemical characterization, spatial distribution and function of a lipoprotein (murein-lipoprotein) of the *E. coli* cell wall. The specific effect of trypsin on the membrane structure. *European Journal of Biochemistry / FEBS*, **10**(3), 426–438. <http://doi.org/10.1111/j.1432-1033.1969.tb00707.x>
- Bui, N. K., Eberhardt, A., Vollmer, D., Kern, T., Bougault, C., Tomasz, A., ... Vollmer, W. (2012). Isolation and analysis of cell wall components from *Streptococcus pneumoniae*. *Analytical Biochemistry*, **421**(2), 657–666. <http://doi.org/10.1016/j.ab.2011.11.026>
- Burmant, L. G., & Park, J. T. (1983). Changes in the Composition of *Escherichia coli* Murein as It

- Ages During Exponential Growth. *Journal of Bacteriology*, **155**(2), 447–453.
- Cava, F., de Pedro, M. A., Lam, H., Davis, B. M., & Waldor, M. K. (2011). Distinct pathways for modification of the bacterial cell wall by non-canonical D-amino acids. *The EMBO Journal*, **30** (16), 3442–3453. <http://doi.org/10.1038/emboj.2011.246>
 - Choudhury, B., Leoff, C., Saile, E., Wilkins, P., Quinn, C. P., Kannenberg, E. L., & Carlson, R. W. (2006). The structure of the major cell wall polysaccharide of *Bacillus anthracis* is species-specific. *Journal of Biological Chemistry*, **281**(38), 27932–27941. <http://doi.org/10.1074/jbc.M605768200>
 - Costa, T. R. D., Felisberto-Rodrigues, C., Meir, A., Prevost, M. S., Redzej, A., Trokter, M., & Waksman, G. (2015). Secretion systems in Gram-negative bacteria : structural and mechanistic insights. *Nature Reviews Microbiology*, **13**(6), 343–359. <http://doi.org/10.1038/nrmicro3456>
 - Daffé, M. (2015). The cell envelope of tubercle bacilli. *Tuberculosis*, **95**, 155–158. <http://doi.org/10.1016/j.tube.2015.02.024>
 - de Pedro, M. A., & Cava, F. (2015). Structural constraints and dynamics of bacterial cell wall architecture. *Frontiers in Microbiology*, **6**(May), 1–10. <http://doi.org/10.3389/fmicb.2015.00449>
 - de Pedro, M. A., & Schwarz, U. (1981). Heterogeneity of newly inserted and preexisting murein in the sacculus of *Escherichia coli*. *Proceedings of the National Academy of Sciences of the United States of America*, **78**(9), 5856–5860. <http://doi.org/10.1073/pnas.78.9.5856>
 - Demchick, P., & Koch, A. L. (1996). The permeability of the wall fabric of *Escherichia coli* and *Bacillus subtilis*. *Journal of Bacteriology*, **178**(3), 768–773.
 - Desmarais, S. M., de Pedro, M. A., Cava, F., & Huang, K. C. (2013). Peptidoglycan at its peaks : How chromatographic analyses can reveal bacterial cell wall structure and assembly. *Molecular Microbiology*, **89**(1), 1–13. <http://doi.org/10.1111/mmi.12266>
 - Dmitriev, B. A., Toukach, F. V., Holst, O., Rietschel, E. T., & Ehlers, S. (2004). Tertiary Structure of *Staphylococcus aureus* Cell Wall Murein. *Journal of Bacteriology*, **186**(21), 7141–7148. <http://doi.org/10.1128/JB.186.21.7141>
 - Dover, R. S., Bitler, A., Shimoni, E., Trieu-Cuot, P., & Shai, Y. (2015). Multiparametric AFM reveals turgor-responsive net-like peptidoglycan architecture in live streptococci. *Nature Communications*, **6**(May), 7193. <http://doi.org/10.1038/ncomms8193>
 - Eberhardt, A., Hoyland, C. N., Vollmer, D., Bisle, S., Cleverley, R. M., Johnsborg, O., ... Vollmer, W. (2012). Attachment of capsular polysaccharide to the cell wall in *Streptococcus pneumoniae*. *Microbial Drug Resistance*, **18**(3), 240–55. <http://doi.org/10.1089/mdr.2011.0232>
 - Errington, J. (2013). L-form bacteria, cell walls and the origins of life. *Open Biology*, **3**(1), 120143. <http://doi.org/10.1098/rsob.120143>
 - Fischbach, M. a, & Walsh, C. T. (2009). Antibiotics for emerging pathogens. *Science*, **325**(5944), 1089–93. <http://doi.org/10.1126/science.1176667>
 - Fritz, G., & Mascher, T. (2014). A balancing act times two : sensing and regulating cell envelope homeostasis in *Bacillus subtilis*. *Molecular Microbiology*, **94**(6), 1201–1207. <http://doi.org/10.1111/mmi.12848>
 - Gan, L., Chen, S., & Jensen, G. J. (2008). Molecular organization of Gram-negative peptidoglycan. *Proceedings of the National Academy of Sciences of the United States of America*, **105**(48), 18953–18957. <http://doi.org/10.1073/pnas.0808035105>
 - Glauner, B., Holtje, J. V., & Schwarz, U. (1988). The composition of the murein of *Escherichia coli*. *Journal of Biological Chemistry*, **263**(21), 10088–10095.
 - Gumbart, J. C., Beeby, M., Jensen, G. J., & Roux, B. (2014). *Escherichia coli* Peptidoglycan Structure and Mechanics as Predicted by Atomic-Scale Simulations. *PLoS Computational Biology*, **10**(2). <http://doi.org/10.1371/journal.pcbi.1003475>

- Harz, H., Burgdorf, K., & Höltje, J. V. (1990). Isolation and separation of the glycan strands from murein of *Escherichia coli* by reversed-phase high-performance liquid chromatography. *Analytical Biochemistry*, **190**(1), 120–128. [http://doi.org/10.1016/0003-2697\(90\)90144-X](http://doi.org/10.1016/0003-2697(90)90144-X)
- Hayhurst, E. J., Kailas, L., Hobbs, J. K., & Foster, S. J. (2008). Cell wall peptidoglycan architecture in *Bacillus subtilis*. *Proceedings of the National Academy of Sciences of the United States of America*, **105**(38), 14603–14608. <http://doi.org/10.1073/pnas.0804138105>
- Jeske, O., Schüler, M., Schumann, P., Schneider, A., Boedeker, C., Jogler, M., ... Jogler, C. (2015). Planctomycetes do possess a peptidoglycan cell wall. *Nature Communications*, **6**(May), 7116. <http://doi.org/10.1038/ncomms8116>
- Klein, R. a., Hartmann, R., Egge, H., Behr, T., & Fischer, W. (1996). The aqueous solution structure of a lipoteichoic acid from *Streptococcus pneumoniae* strain R6 containing 2,4-diamino-2,4,6-trideoxy-galactose : evidence for conformational mobility of the galactopyranose ring. *Carbohydrate Research*, **281**(1), 79–98. [http://doi.org/10.1016/0008-6215\(95\)00336-3](http://doi.org/10.1016/0008-6215(95)00336-3)
- Koch, A. L., Lane, S. L., Miller, J. A., & Nickens, D. G. (1987). Contraction Of Filaments Of *Escherichia-Coli* After Disruption Of Cell-Membrane By Detergent. *Journal of Bacteriology*, **169**(5), 1979–1984.
- Koch, A. L., & Woeste, S. (1992). Elasticity Of The Sacculus Of *Escherichia-coli*. *Journal of Bacteriology*, **174**(14), 4811–4819.
- Kuru, E., Hughes, H. V., Brown, P. J., Hall, E., Tekkam, S., Cava, F., ... Vannieuwenhze, M. S. (2012). In situ probing of newly synthesized peptidoglycan in live bacteria with fluorescent D-amino acids. *Angewandte Chemie – International Edition*, **51**(50), 12519–12523. <http://doi.org/10.1002/anie.201206749>
- Kuru, E., Tekkam, S., Hall, E., Brun, Y. V., & Van Nieuwenhze, M. S. (2015). Synthesis of fluorescent D-amino acids and their use for probing peptidoglycan synthesis and bacterial growth *in situ*. *Nature Protocols*, **10**(1), 33–52. <http://doi.org/10.1038/nprot.2014.197>
- Labischinski, H., Goodell, E. W., Goodell, a., & Hochberg, M. L. (1991). Direct proof of a “more-than-single-layered” peptidoglycan architecture of *Escherichia coli* W7 : A neutron small-angle scattering study. *Journal of Bacteriology*, **173**(2), 751–756. <http://doi.org/10.1128/JB.00239-08>
- Lavollay, M., Arthur, M., Fourgeaud, M., Dubost, L., Marie, A., Veziris, N., ... Mainardi, J. L. (2008). The peptidoglycan of stationary-phase *Mycobacterium tuberculosis* predominantly contains cross-links generated by L,D-transpeptidation. *Journal of Bacteriology*, **190**(12), 4360–4366. <http://doi.org/10.1128/JB.00239-08>
- Leaver, M., Domínguez-Cuevas, P., Coxhead, J. M., Daniel, R. a., & Errington, J. (2009). Life without a wall or division machine in *Bacillus subtilis*. *Nature*, **457**(7231), 849–853. <http://doi.org/10.1038/nature08232>
- Liechti, G. W., Kuru, E., Hall, E., Kalinda, A., Brun, Y. V., VanNieuwenhze, M., & Maurelli, a T. (2014). A new metabolic cell-wall labelling method reveals peptidoglycan in *Chlamydia trachomatis*. *Nature*, **506**(7489), 507–10. <http://doi.org/10.1038/nature12892>
- Loskill, P., Pereira, P. M., Jung, P., Bischoff, M., Herrmann, M., Pinho, M. G., & Jacobs, K. (2014). Reduction of the peptidoglycan crosslinking causes a decrease in stiffness of the *Staphylococcus aureus* cell envelope. *Biophysical Journal*, **107**(5), 1082–1089. <http://doi.org/10.1016/j.bpj.2014.07.029>
- Lower, B. H., & Bazylinski, D. a. (2013). The bacterial magnetosome : A unique prokaryotic organelle. *Journal of Molecular Microbiology and Biotechnology*, **23**(1-2), 63–80. <http://doi.org/10.1159/000346543>
- Magnet, S., Bellais, S., Dubost, L., Fourgeaud, M., Mainardi, J. L., Petit-Frère, S., ... Gutmann, L. (2007). Identification of the L,D-transpeptidases responsible for attachment of the Braun

lipoprotein to *Escherichia coli* peptidoglycan. *Journal of Bacteriology*, **189**(10), 3927–3931. <http://doi.org/10.1128/JB.00084-07>

- Mainardi, J. L., Fourgeaud, M., Hugonnet, J. E., Dubost, L., Brouard, J. P., Ouazzani, J., ... Arthur, M. (2005). A novel peptidoglycan cross-linking enzyme for a β -lactam-resistant transpeptidation pathway. *Journal of Biological Chemistry*, **280**(46), 38146–38152. <http://doi.org/10.1074/jbc.M507384200>
- Mainardi, J. L., Legrand, R., Arthur, M., Schoot, B., Van Heijenoort, J., & Gutmann, L. (2000). Novel mechanism of β -lactam resistance due to bypass of DD- transpeptidation in *Enterococcus faecium*. *Journal of Biological Chemistry*, **275**(22), 16490–16496. <http://doi.org/10.1074/jbc.M909877199>
- Mainardi, J. L., Morel, V., Fourgeaud, M., Cremniter, J., Blanot, D., Legrand, R., ... Gutmann, L. (2002). Balance between two transpeptidation mechanisms determines the expression of β -lactam resistance in *Enterococcus faecium*. *Journal of Biological Chemistry*, **277**(39), 35801–35807. <http://doi.org/10.1074/jbc.M204319200>
- Mason, O. U., Nakagawa, T., Rosner, M., van Nostrand, J. D., Zhou, J., Maruyama, A., ... Giovannoni, S. J. (2010). First investigation of the microbiology of the deepest layer of ocean crust. *PLoS ONE*, **5**(11). <http://doi.org/10.1371/journal.pone.0015399>
- Matias, V. R. F., Al-amoudi, A., Dubochet, J., & Beveridge, T. J. (2003). Cryo-Transmission Electron Microscopy of Frozen-Hydrated Sections of *Escherichia coli* and *Pseudomonas aeruginosa*. *Journal of Bacteriology*, **185**(20), 6112–6118. <http://doi.org/10.1128/JB.185.20.6112>
- Matias, V. R. F., & Beveridge, T. J. (2005). Cryo-electron microscopy reveals native polymeric cell wall structure in *Bacillus subtilis*168 and the existence of a periplasmic space. *Molecular Microbiology*, **56**(1), 240–251. <http://doi.org/10.1111/j.1365-2958.2005.04535.x>
- Matias, V. R. F., & Beveridge, T. J. (2006). Native cell wall organization shown by cryo-electron microscopy confirms the existence of a periplasmic space in *Staphylococcus aureus*. *Journal of Bacteriology*, **188**(3), 1011–1021. <http://doi.org/10.1128/JB.188.3.1011-1021.2006>
- Meroueh, S. O., Bencze, K. Z., Heseck, D., Lee, M., Fisher, J. F., Stemmler, T. L., & Mobashery, S. (2006). Three-dimensional structure of the bacterial cell wall peptidoglycan. *Proceedings of the National Academy of Sciences of the United States of America*, **103**(12), 4404–4409. <http://doi.org/10.1073/pnas.0510182103>
- Modi, S. R., Collins, J. J., & Relman, D. A. (2014). Antibiotics and the gut microbiota. *The Journal of Clinical Investigation*, **124**(10), 4212–8. <http://doi.org/10.1172/JCI72333.The>
- Morimoto, Y., & Minamino, T. (2014). Structure and Function of the Bi-Directional Bacterial Flagellar Motor. *Biomolecules*, **4**(1), 217–234. <http://doi.org/10.3390/biom4010217>
- Moynihan, P. J., Sychantha, D., & Clarke, A. J. (2014). Chemical biology of peptidoglycan acetylation and deacetylation. *Bioorganic Chemistry*, **54**, 44–50. <http://doi.org/10.1016/j.bioorg.2014.03.010Minireview>
- Orf, G. S., & Blankenship, R. E. (2013). Chlorosome antenna complexes from green photosynthetic bacteria. *Photosynthesis Research*, **116**(2-3), 315–331. <http://doi.org/10.1007/s11220-013-9869-3>
- Park, H. J., Kang, K. M., Dybvig, K., Lee, B. L., Jung, Y. W., & Lee, I. H. (2013). Interaction of cationic antimicrobial peptides with *Mycoplasma pulmonis*. *FEBS Letters*, **587**(20), 3321–3326. <http://doi.org/10.1016/j.febslet.2013.08.016>
- Pedersen, C. M., Figueroa-Perez, I., Boruwa, J., Lindner, B., Ulmer, A. J., Zähringer, U., & Schmidt, R. R. (2010). Synthesis of the core structure of the lipoteichoic acid of *Streptococcus pneumoniae*. *Chemistry – A European Journal*, **16**(42), 12627–12641. <http://doi.org/10.1002/chem.201001204>

- Pilhofer, M., Aistleitner, K., Biboy, J., Gray, J., Kuru, E., Hall, E., ... Jensen, G. J. (2013). Discovery of chlamydial peptidoglycan reveals bacteria with murein sacculi but without FtsZ. *Nature Communications*, **4**, 2856. <http://doi.org/10.1038/ncomms3856>
- Pisabarro, A. G., de Pedro, M. A., & Vazquez, D. (1985). Structural modifications in the peptidoglycan of *Escherichia coli* associated with changes in the state of growth of the culture. *Journal of Bacteriology*, **161**(1), 238–242.
- Putker, F., Bos, M. P., & Tommassen, J. (2015). Transport of lipopolysaccharide to the Gram-negative bacterial cell surface. *FEMS Microbiology Reviews*, (February), 1–18. <http://doi.org/10.1093/femsre/fuv026>
- Rae, B. D., Long, B. M., Whitehead, L. F., Förster, B., Badger, M. R., & Price, G. D. (2013). Cyanobacterial carboxysomes : Microcompartments that facilitate CO₂ fixation. *Journal of Molecular Microbiology and Biotechnology*, **23**(4-5), 300–307. <http://doi.org/10.1159/000351342>
- Schlag, M., Biswas, R., Krismer, B., Kohler, T., Zoll, S., Yu, W., ... Götz, F. (2010). Role of staphylococcal wall teichoic acid in targeting the major autolysin Atl. *Molecular Microbiology*, **75** (4), 864–873. <http://doi.org/10.1111/j.1365-2958.2009.07007.x>
- Silhavy, T. J., Kahne, D., & Walker, S. (2010). The bacterial cell envelope. *Cold Spring Harbor Perspectives in Biology*, **2**(5), a000414. <http://doi.org/10.1101/cshperspect.a000414>
- Turner, R. D., Hurd, A. F., Cadby, A., Hobbs, J. K., & Foster, S. J. (2013). Cell wall elongation mode in Gram-negative bacteria is determined by peptidoglycan architecture. *Nature Communications*, **4**, 1496. <http://doi.org/10.1038/ncomms2503>
- Turner, R. D., Ratcliffe, E. C., Wheeler, R., Golestanian, R., Hobbs, J. K., & Foster, S. J. (2010). Peptidoglycan architecture can specify division planes in *Staphylococcus aureus*. *Nature Communications*, **1**(3), 26. <http://doi.org/10.1038/ncomms1025>
- Turner, R. D., Vollmer, W., & Foster, S. J. (2014). Different walls for rods and balls : The diversity of peptidoglycan. *Molecular Microbiology*, **915**, 862–874. <http://doi.org/10.1111/mmi.12513>
- van Teeseling, M. C. F., Mesman, R. J., Kuru, E., Espallat, A., Cava, F., Brun, Y. V., ... van Niftrik, L. (2015). Anammox Planctomycetes have a peptidoglycan cell wall. *Nature Communications*, **6**(May), 6878. <http://doi.org/10.1038/ncomms7878>
- Vázquez-laslop, N., Lee, H., Hu, R., & Alex, A. (2001). Molecular Sieve Mechanism of Selective Release of Cytoplasmic Proteins by Osmotically Shocked *Escherichia coli*. *Journal of Bacteriology*, **183**(8), 2399–2404. <http://doi.org/10.1128/JB.183.8.2399>
- Voadlo, D. J., Davies, G. J., Laine, R., & Withers, S. G. (2001). Catalysis by hen egg-white lysozyme proceeds via a covalent intermediate. *Nature*, **412**(6849), 835–838. <http://doi.org/10.1038/35090602>
- Vollmer, W. (2008). Structural variation in the glycan strands of bacterial peptidoglycan. *FEMS Microbiology Reviews*, **32**(2), 287–306. <http://doi.org/10.1111/j.1574-6976.2007.00088.x>
- Vollmer, W., Blanot, D., & de Pedro, M. A. (2008). Peptidoglycan structure and architecture. *FEMS Microbiology Reviews*, **32**(2), 149–67. <http://doi.org/10.1111/j.1574-6976.2007.00094.x>
- Vollmer, W., & Höltje, J. V. (2004). The Architecture of the Murein (Peptidoglycan) in Gram-Negative Bacteria : Vertical Scaffold or Horizontal Layer (s) ? *Journal of Bacteriology*, **186**(18), 5978–5987. <http://doi.org/10.1128/JB.186.18.5978>
- Vollmer, W., Joris, B., Charlier, P., & Foster, S. J. (2008). Bacterial peptidoglycan (murein) hydrolases. *FEMS Microbiology Reviews*, **32**(2), 259–86. <http://doi.org/10.1111/j.1574-6976.2007.00099.x>
- Vollmer, W., & Seligman, S. J. (2010). Architecture of peptidoglycan : more data and more models. *Trends in Microbiology*, **18**(2), 59–66. <http://doi.org/10.1016/j.tim.2009.12.004>

- Vollmer, W., Von Rechenberg, M., & Höltje, J. V. (1999). Demonstration of molecular interactions between the murein polymerase PBP1B, the lytic transglycosylase MltA, and the scaffolding protein MipA of *Escherichia coli*. *Journal of Biological Chemistry*, **274**(10), 6726–6734. <http://doi.org/10.1074/jbc.274.10.6726>
- von Rechenberg, M., Ursinus, A., & Höltje, J. V. (1996). Affinity chromatography as a means to study multienzyme complexes involved in murein synthesis. *Microbial Drug Resistance*, **2**(1), 155–157. <http://doi.org/10.1089/mdr.1996.2.155>
- Vötsch, W., & Templin, M. F. (2000). Characterization of a β -N-acetylglucosaminidase of *Escherichia coli* and elucidation of its role in muropeptide recycling and β -lactamase induction. *Journal of Biological Chemistry*, **275**(50), 39032–39038. <http://doi.org/10.1074/jbc.M004797200>
- Wang, G., Olczak, A., Forsberg, L. S., & Maier, R. J. (2009). Oxidative stress-induced Peptidoglycan deacetylase in *Helicobacter pylori*. *Journal of Biological Chemistry*, **284**(11), 6790–6800. <http://doi.org/10.1074/jbc.M808071200>
- Wang, L., & Lutkenhaus, J. (1998). FtsK is an essential cell division protein that is localized to the septum and induced as part of the SOS response. *Molecular Microbiology*, **29**(3), 731–740. <http://doi.org/10.1046/j.1365-2958.1998.00958.x>
- Wasserman, S. a., Walsh, C. T., & Botstein, D. (1983). Two alanine racemase genes in *Salmonella typhimurium* that differ in structure and function. *Journal of Bacteriology*, **153**(3), 1439–1450.
- Watanabe, A., Yoshimura, T., Mikami, B., Hayashi, H., Kagamiyama, H., & Esaki, N. (2002). Reaction mechanism of alanine racemase from *Bacillus stearothermophilus* : X-ray crystallographic studies of the enzyme bound with N-(5 β -phosphopyridoxyl)alanine. *Journal of Biological Chemistry*, **277**(21), 19166–19172. <http://doi.org/10.1074/jbc.M201615200>
- Weadge, J. T., & Clarke, A. J. (2006). Identification and characterization of O-acetylpeptidoglycan esterase : A novel enzyme discovered in *Neisseria gonorrhoeae*. *Biochemistry*, **45**(3), 839–851. <http://doi.org/10.1021/bi051679s>
- Weadge, J. T., Pfeffer, J. M., & Clarke, A. J. (2005). Identification of a new family of enzymes with potential O-acetylpeptidoglycan esterase activity in both Gram-positive and Gram-negative bacteria. *BMC Microbiology*, **5**, 49. <http://doi.org/10.1186/1471-2180-5-49>
- Weidenmaier, C., & Peschel, A. (2008). Teichoic acids and related cell-wall glycopolymers in Gram-positive physiology and host interactions. *Nature Reviews Microbiology*, **6**(4), 276–287. <http://doi.org/10.1038/nrmicro1861>
- Weiss, D. S. (2015). Last but not least : new insights into how FtsN triggers constriction during *Escherichia coli* cell division. *Molecular Microbiology*, **95**(6), 903–909. <http://doi.org/10.1111/mmi.12925>
- Weiss, D. S., Pogliano, K., Carson, M., Guzman, L. M., Fraipont, C., Nguyen-Distèche, M., ... Beckwith, J. (1997). Localization of the *Escherichia coli* cell division protein FtsI (PBP3) to the division site and cell pole. *Molecular Microbiology*, **25**(4), 671–681.
- Wheeler, R., Mesnage, S., Boneca, I. G., Hobbs, J. K., & Foster, S. J. (2011). Super-resolution microscopy reveals cell wall dynamics and peptidoglycan architecture in ovococcal bacteria. *Molecular Microbiology*, **82**(5), 1096–1109. <http://doi.org/10.1111/j.1365-2958.2011.07871.x>
- White, C. L., Kitich, A., & Gober, J. W. (2010). Positioning cell wall synthetic complexes by the bacterial morphogenetic proteins MreB and MreD. *Molecular Microbiology*, **76**(3), 616–633. <http://doi.org/10.1111/j.1365-2958.2010.07108.x>
- White, R. J., & Pasternak, C. a. (1967). The purification and properties of N-acetylglucosamine 6-phosphate deacetylase from *Escherichia coli*. *The Biochemical Journal*, **105**(1), 121–125.
- Wientjes, F. B., Woldringh, C. L., & Nanninga, N. (1991). Amount of Peptidoglycan in Cell Walls

of Gram-Negative Bacteria. *J Bacteriol*, **173**(23), 7684–7691.

- Wild, J., Hennig, J., Lobočka, M., Walczak, W., & Kłopotowski, T. (1985). Identification of the *dadX* gene coding for the predominant isozyme of alanine racemase in *Escherichia coli* K12. *MGG Molecular & General Genetics*, **198**(2), 315–322. <http://doi.org/10.1007/BF00383013>
- Williams, A. H., Veyrier, F. J., Bonis, M., Michaud, Y., Raynal, B., Taha, M.-K., ... Boneca, I. G. (2014). Visualization of a substrate-induced productive conformation of the catalytic triad of the *Neisseria meningitidis* peptidoglycan O-acetyltransferase reveals mechanistic conservation in SGNH esterase family members. *Acta Crystallographica Section D Biological Crystallography*, **70**(10), 2631–2639. <http://doi.org/10.1107/S1399004714016770>
- Williams, K. B., Yahashiri, A., Arends, S. J. R., Popham, D. L., Fowler, C. A., & Weiss, D. S. (2013). Nuclear magnetic resonance solution structure of the peptidoglycan-binding SPOR domain from *Escherichia coli* DamX : Insights into septal localization. *Biochemistry*, **52**(4), 627–639. <http://doi.org/10.1021/bi301609e>
- Witty, M., Sanz, C., Shah, A., Grossmann, J. G., Mizuuchi, K., Perham, R. N., & Luisi, B. (2002). Structure of the periplasmic domain of *Pseudomonas aeruginosa* TolA : Evidence for an evolutionary relationship with the TonB transporter protein. *EMBO Journal*, **21**(16), 4207–4218. <http://doi.org/10.1093/emboj/cdf417>
- Woese, C. R., Kandler, O., & Wheelis, M. L. (1990). Towards a natural system of organisms : proposal for the domains Archaea, Bacteria, and Eucarya. *Proceedings of the National Academy of Sciences of the United States of America*, **87**(12), 4576–4579. <http://doi.org/10.1073/pnas.87.12.4576>
- Xia, G., Kohler, T., & Peschel, A. (2010). The wall teichoic acid and lipoteichoic acid polymers of *Staphylococcus aureus*. *International Journal of Medical Microbiology*, **300**(2-3), 148–154. <http://doi.org/10.1016/j.ijmm.2009.10.001>
- Yahashiri, A., Jorgenson, M. A., & Weiss, D. S. (2015). Bacterial SPOR domains are recruited to septal peptidoglycan by binding to glycan strands that lack stem peptides. *Proceedings of the National Academy of Sciences*. <http://doi.org/10.1073/pnas.1508536112>
- Yang, D. C., Peters, N. T., Parzych, K. R., Uehara, T., Markovski, M., & Bernhardt, T. G. (2011). An ATP-binding cassette transporter-like complex governs cell-wall hydrolysis at the bacterial cytokinetic ring. *Proceedings of the National Academy of Sciences of the United States of America*. <http://doi.org/10.1073/pnas.1107780108>
- Yang, D. C., Tan, K., Joachimiak, A., & Bernhardt, T. G. (2012). A conformational switch controls cell wall-remodelling enzymes required for bacterial cell division. *Molecular Microbiology*, **85**(4), 768–781. <http://doi.org/10.1111/j.1365-2958.2012.08138.x>
- Yang, J. C., van den Ent, F., Neuhaus, D., Brevier, J., & Löwe, J. (2004). Solution structure and domain architecture of the divisome protein FtsN. *Molecular Microbiology*, **52**(3), 651–660. <http://doi.org/10.1111/j.1365-2958.2004.03991.x>
- Yao, X., Jericho, M., Pink, D., & Beveridge, T. (1999). Thickness and elasticity of gram-negative murein sacculi measured by atomic force microscopy. *Journal of Bacteriology*, **181**(22), 6865–6875.
- Yoon, J., Matsuo, Y., Matsuda, S., Kasai, H., & Yokota, A. (2010). *Cerasicoccus maritimus* sp. nov. and *Cerasicoccus frondis* sp. nov., two peptidoglycan-less marine Verrucomicrobial species, and description of Verrucomicrobia phyl. nov., nom. rev. *The Journal of General and Applied Microbiology*, **56**(3), 213–222. <http://doi.org/10.2323/jgam.56.213>

- Yousif, S. Y., Broome-Smith, J. K., & Spratt, B. G. (1985). Lysis of *Escherichia coli* by beta-lactam antibiotics : deletion analysis of the role of penicillin-binding proteins 1A and 1B. *Journal of General Microbiology*, **131**(10), 2839–2845. <http://doi.org/10.1099/00221287-131-10-2839>
- Yuan, Y., Barrett, D., Zhang, Y., Kahne, D., Sliz, P., & Walker, S. (2007). Crystal structure of a peptidoglycan glycosyltransferase suggests a model for processive glycan chain synthesis. *Proceedings of the National Academy of Sciences of the United States of America*, **104**(13), 5348–5353. <http://doi.org/10.1073/pnas.0701160104>
- Zapun, A., Contreras-Martel, C., & Vernet, T. (2008). Penicillin-binding proteins and β -lactam resistance. *FEMS Microbiology Reviews*, **32**(2), 361–385. <http://doi.org/10.1111/j.1574-6976.2007.00095.x>
- Zapun, A., Philippe, J., Abrahams, K. a., Signor, L., Roper, D. I., Breukink, E., & Vernet, T. (2013). *In vitro* reconstitution of peptidoglycan assembly from the gram-positive pathogen *Streptococcus pneumoniae*. *ACS Chemical Biology*, **8**(12), 2688–2696. <http://doi.org/10.1021/cb400575t>
- Zawadzke, L. E., Bugg, T. D., & Walsh, C. T. (1991). Existence of two D-alanine:D-alanine ligases in *Escherichia coli* : cloning and sequencing of the *ddlA* gene and purification and characterization of the DdlA and DdlB enzymes. *Biochemistry*, **30**(6), 1673–1682. <http://doi.org/10.1021/bi00220a033>
- Zeng, X., & Lin, J. (2013). Beta-lactamase induction and cell wall metabolism in Gram-negative bacteria. *Frontiers in Microbiology*, **4**(MAY), 1–9. <http://doi.org/10.3389/fmicb.2013.00128>
- Zijderveld, C. a L., Aarsman, M. E. G., Den Blaauwen, T., & Nanninga, N. (1991). Penicillin-binding protein 1B of *Escherichia coli* exists in dimeric forms. *Journal of Bacteriology*, **173**(18), 5740–5746.
- Zuber, B., Chami, M., Houssin, C., Dubochet, J., Griffiths, G., & Daffé, M. (2008). Direct visualization of the outer membrane of mycobacteria and corynebacteria in their native state. *Journal of Bacteriology*, **190**(16), 5672–5680. <http://doi.org/10.1128/JB.01919-07>